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1 "Antenna for transceiver devices or the like"

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5 The invention relates to an antenna for transceiver devices or the like.

In the transceiver devices, extraction, from the modulated carrier wave received, of the modulation signals containing logic information, and superimposition, on the
10 carrier wave transmitted, of the logic information contained in local modulation signals are generally performed by means of demodulators and modulators. Modulators and demodulators are also used in so-called "transponders", i.e. receiving/reflecting devices which, instead of generating their own
15 transmission carrier wave, use for transmission the carrier wave, preferably unmodulated, which they receive from a remote transmitting station and which is modulated by them and then reflected back. These devices possess the advantage that they do not require local oscillators and the
20 corresponding power circuits for generation of the carrier wave. On account of their small dimensions, they are used extensively in telecommunications and in control and remote identification systems where they are combined with local control devices or with the identification units. The
25 frequency ranges used may be of any kind and in particular are within the microwave range. Owing to the growing automation and robotisation of industrial processes and plants of all kinds, there is a tendency towards increasingly widespread use of such systems. This has given
30 rise to the need to improve the transceiver/reflecting



1 devices and reduce their costs and dimensions as far as possible, with the development of special technologies in the microwave range.

The object of the invention, therefore, is to provide an antenna for transceiver devices or the like, in particular for receiving/reflecting devices, which results in a simple, inexpensive and extremely compact design of such devices, all of which without adversely affecting, but on the contrary actually improving their operation and performance.

10 The invention achieves the above objects with an antenna for transceiver devices or the like, in which a single detector/mixer diode is associated with a radiating antenna structure so as to form a single integrated device which is alternately able to receive a modulated carrier wave and
15 demodulate from the said wave the modulation signals received as well modulate, with local modulation signals, a carrier wave transmitted, while the point for detecting and supplying the modulation signals of the modulated carrier wave received and the local modulation signals transmitted
20 coincides with a point of the radiating antenna structure, where the electric field of the carrier wave is equal to zero.

According to a preferred embodiment, the antenna has at least one resonating/radiating conductor which is connected
25 via a detector/mixer diode to an earth, the detector/mixer diode being oriented in the direction of conduction from the resonating/radiating conductor to the earth, and the connection of the detector/mixer diode to the resonating/radiating conductor being effected at such a
30 point of the said conductor (insertion point) as to obtain



1 optimum impedance matching, during reception and transmission, between the characteristic impedance of the radiating antenna structure at the insertion point and the impedance of the detector/mixer diode.

5 The antenna is able to receive a carrier wave, preferably unmodulated, and modulate the said wave with local modulation signals, reflecting it back.

Demodulation of the signals received and modulation with the local transmission signals is therefore performed.
10 without having to use separate demodulators and modulators, together with the corresponding filters, local oscillators and the usual circuitry associated with them. In addition to the reduction in the number of components and the extremely simple design, a considerable reduction in the dimensions is
15 also achieved. The point chosen for detection and supplying of the modulation signals received and transmitted ensures that the carrier is confined entirely in the resonating/radiating conductor, and the point of insertion chosen for the detector/mixer diode on the
20 resonating/radiating conductor forms the optimum connection between diode and conductor. This results in optimisation of both the level of the demodulated signals received and the efficiency of reflection of the locally modulated carrier.

The invention also relates to other features which
25 further improve the abovementioned antenna and which are described in the subclaims.

The characteristic details of the invention and the advantages resulting therefrom will emerge more clearly from the description of a preferred embodiment, illustrated by
30 way of a non-limiting example in the accompanying drawings,



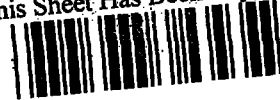
1 in which:

Figure 1 shows a perspective view of the side of the antenna constructed in microstrip technology, where the so-called patch is located;

5 Figure 2 shows a cross-section through the antenna of Figure 1 in the area of the detector/mixer diode and along the line II-II of Figure 3.

Figure 3 shows a plan view of the side of the antenna according to the preceding figures, where the so-called
10 reference earth plane is located.

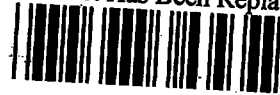
In the example shown in the Figures, the antenna according to the invention is constructed in so-called microstrip technology, already used for the construction of waveguides for propagating signals in the microwave briefly
15 "antenna" below, consists of two conductors separated by a solid dielectric element. The said structure comprises a rectangular plate 2 of dielectric material, on each face of which a thin conducting plate 3, 4 is fixed. One of the two
conducting plates 4, called an "earth plane", covers the
20 entire surface of the dielectric plate 2. The other conducting plate 3, the so-called "patch", is arranged in the centre of the opposite face of the dielectric plate 2 and has a rectangular shape with dimensions significantly smaller than those of the earth plane 4. The so-called patch
25 3 forms the resonating/radiating conductor, while the earth plane 4 performs the function of an artificial earth. From a supply and detection point P of the patch 3, namely in this case the central point of one of its shortest sides 103, there extends an input/output conductor 5 to which the
30 remainder of the circuit of a transceiver device (not



1 shown), for example a transponder, is connected.

A diode 6 connects the patch 3 to the earth plane 4. The point of connection of the diode 6 to the patch 3, the so-called insertion point I, coincides with the median axis 5 M parallel to the shortest side 103 of the patch 3, while it is arranged at a given distance D from one of the longitudinal ~~sides~~ 203 of the patch 3 perpendicular to the said median axis M. The ~~diode 6~~ is arranged in the direction of conduction from the patch 3 to the earth plane 4 (Figure 10 2) and is fixed to the antenna 1 on the side where the earth plane 4 is located. In particular (Figure 2), in the region of the insertion point I, the earth plane 4 has a through-aperture 104, inside which an extension 7 of the patch 3 forming a connection to the detector/mixer diode 6 15 is accommodated so as to be electrically insulated from the earth plane 4 itself. The connection extension 7, on the side where the earth plane 4 is located, is connected electrically to the patch 3 by means of a tubular conducting bush 8 which passes from one side to the other of the 20 dielectric plate 2 through a hole 102 coinciding with the insertion point I itself.

The insertion point I of the detector/mixer diode 6 is determined so as to obtain the optimum impedance matching of the antenna 1 with the detector/mixer diode 6. Determination 25 of the insertion point I is not easy, since the detector/mixer diode 6 acts alternately as a loading device for the antenna 1 and generator, during reception and transmission. Matching of the impedance of the antenna 1 at the insertion point I with the impedance of the 30 detector/mixer diode 6 must be performed taking this into



1 account, in order to optimise simultaneously the efficiency during reception and that during transmission/reflection.

For this purpose, the insertion point I may be determined experimentally or theoretically. In the latter
5 case, the insertion point I is calculated to a good and adequate degree of approximation, as is the point of the patch 3, the input impedance of which assumes a predetermined value matching the impedance of the detector/mixer diode 6, in particular for example of the
10 order of magnitude of the impedance of the detector/mixer diode 6 or approximately identical to the impedance of the same at the resonant frequency w_{10} of the radiating antenna structure (1). Obviously the radiating structure (1) is constructed such that the resonant frequency w_{10} coincides
15 substantially with the frequency of the carrier wave.

With reference to the present example in which the insertion point I is arranged on the median axis M of the patch 3 parallel to the side 103 on which the detection and supply point P is provided, the distance D of the insertion
20 point I from one of the sides 203 of the patch 3 transverse relative to the said median axis M is defined by the relation with the input impedance Z_{in} of the radiating structure 1 at the insertion point I at the resonant frequency w_{10} :

$$25 \quad Z_{in} = Z_{in}(L, W, D, h, K_o, Z_o, \epsilon_r, Q_T, w_{10})$$

where:

L: length of the side 203 of the patch 3

W: length of the side 103 of the patch 3

D: distance of the insertion point I from the side 203 of
30 the patch 3



1 h: distance of the patch 3 from the earth plane 4

K_0 : $2\pi/\lambda_0$ with λ_0 : wavelength in air

Z_0 : characteristic impedance of vacuum

ϵ_r : dielectric constant

5 Q_T : merit factor of the antenna (calculable)

w_{10} : resonant frequency.

The point P for detecting and supplying the demodulated signals received and the local modulation signals is determined so as to coincide with the point of the patch 3. 10 where the electric field generated by the carrier wave is equal to zero.

During reception of a modulated carrier wave, the diode 6 acts as detector, extracting from the modulated carrier the modulation signals and hence the information transmitted 15 therein. Owing to the particular arrangement of the insertion point I, the level of the demodulated signals is optimised. As a result of the positioning of the detection and supply point P, automatic filtering of all the components of the carrier wave confined in the patch 3 can 20 be achieved. Only the baseband signals relating to the information transmitted are output from the patch 3, thus avoiding the need for both a conventional envelope demodulator and the filters associated therewith.

During reflection, the diode 6 acts as a modulator of 25 the carrier wave which during this phase is transmitted preferably unmodulated and which is confined in the patch 3. The local modulation signals are sent to the antenna 1 at the detection and supply point P. Modulation can be performed without the use of local oscillators and the usual 30 additional circuits associated therewith. The arrangement of



1 the point P for detecting and supplying the modulated
signals received and transmitted, and of the insertion point
I of the diode 6 prevent diffusion of the carrier wave
beyond the detection and supply point P towards the internal
5 circuits and thus result in optimum efficiency of reflection
of the carrier wave itself, modulated with the local
modulation signals.

The efficiency of the antenna according to the invention
both during reception and transmission/reflection is also
10 influenced by additional parameters which depend in each
case on the operating conditions, such as type of
modulation, structure of the analog or digital signals,
wavelength of the carrier and frequency of the modulation
signals, and type of polarisation. All of this influences
15 the dimensions of the antenna, the choice of diode, the
polarisation current of the diode, where present, and the
orientation of the antenna and/or the diode itself.

In the case, for example, of a system with at least one
transmitting/receiving station and a transponder, in which a
20 carrier wave of between 5.72 and 5.8 GHz is used to send
information to the transponder, it is appropriate to
modulate the amplitude of the carrier, whereas, in order to
send data from the transponder to the station, the carrier
is frequency-modulated. When the data received and
25 transmitted are of the digital type it is preferable to use
ASK amplitude modulation during reception and frequency
modulation of the carrier during transmission/reflection, as
in the case where the carrier is mixed with a medium
frequency signal obtained from frequency modulation, for
30 example FEK modulation.



1 By varying the polarisation current of the
detector/mixer diode 6, it is possible to modify and correct
the waveform and the amplitude of the modulating signals, in
particular during reception.

5 In this case, the dimensions of the antenna, in
particular the patch 3, are extremely small, namely of the
order of ten millimetres or so for the side 103 and 203,
while the distance D of the insertion point from the side
203 of the patch 3 is a few millimetres. Further-more, in
10 view of the extremely small dimensions of the patch 3, the
tolerances for determining the insertion point I are
relatively large, the extension of the pins 106 of the
detector/mixer diode 6 not being insignificant compared to
the surface area of the patch 3. In this case, for most of
15 the commercially available diodes 6 with characteristics
suitable for the purpose, it has been shown that the
impedance matching between radiating antenna structure 1 and
diode 6 is almost always ensured, within the context of the
operational requirements of the antenna, when the impedance
20 of the radiating structure 1, or the patch 3, at the
insertion point is between 10 and 100 ohms, in particular
from 40 to 50 ohms.

With special plane polarisation of the carrier wave, the
efficiency of the antenna both during reception and
25 reflection is optimum when, as shown in Figure 3, the diode
6 is oriented with the axis C which joins the two pins 106,
parallel to the side 203 of the patch 3, the said side 203
of the patch 3 and the said axis C being oriented at an
angle of 90° with respect to the plane containing the
30 electric field of the carrier wave.



1 Obviously, the invention is not limited to the
embodiments described and illustrated herein, but may also
be substantially varied and modified, in particular from a
constructional point of view. The antenna/diode structure of
5 the present invention may be used with any type of radiating
antenna structure for any type of use, all of which without
departing from the underlying principle described above and
claimed below.

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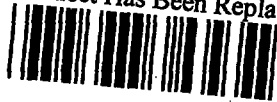
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1. Antenna for transceiver devices or the like
5 characterised in that a single detector/mixer diode (6) is
associated with a radiating antenna structure (1) so as to
form a single integrated device which is alternately able to
receive a modulated carrier wave and demodulate from the
said wave the modulation signals received as well as
10 modulate, with local modulation signals, a locally generated
carrier wave transmitted, or modulate an unmodulated carrier
wave received, reflecting it back, while the modulation
signals of the modulated carrier wave received and the local
modulation signals transmitted are respectively detected and
15 supplied to the radiating structure (1) at a point (P) of
the said structure, where the electric field of the carrier
wave is equal to zero.

2. Antenna according to Claim 1, characterised in that it
has at least one resonating/radiating conductor (3) which
20 has a resonant frequency corresponding to the frequency of
the carrier wave used and which is connected via a
detector/mixer diode (6) to an earth (4), the detector/mixer
diode (6) being oriented in the direction of conduction from
the resonating/radiating conductor (3) to the earth (4) and
25 the detector/mixer diode (6) being connected to the
resonating/radiating conductor (3) at such a point (I) of
the said conductor (insertion point) as to obtain optimum
impedance matching between the characteristic impedance of
the radiating structure (1), or the resonating/radiating
30 conductor (3), with reference to the said insertion point

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- 1 (I), and the impedance of the detector/mixer diode (6).
3. Antenna according to Claims 1 or 2, characterised in that the point of insertion (I) of the detector/mixer diode (6) on the resonating/radiating conductor (3) coincides with
- 5 the point of the resonating/radiating conductor (3) where the characteristic impedance is of the order of magnitude of or substantially identical to the impedance of the detector/mixer (6) at the resonant frequency w_{10} corresponding to the frequency of the carrier wave.
- 10 4. Antenna according to one or more of the preceding claims, characterised in that the detector/mixer diode (6) may have applied to it a polarisation current which constitutes a parameter for adjusting and correcting the waveform and amplitude, in particular of the modulation
- 15 signals received.
5. Antenna according to one or more of the preceding claims, characterised in that, with a predetermined direction of polarisation of the carrier waves, the detector/mixer diode (6) and/or the radiating structure (1)
- 20 are also oriented in a predetermined manner with respect to the direction of polarisation of the carrier wave corresponding to maximum efficiency of reception and transmission or reflection.
6. Antenna according to one or more of the preceding
- 25 claims, characterised in that it is able to be associated with a receiving/reflecting device, of the known type called a "transponder", in particular for use with carrier waves in the microwave range, the radiating structure (1) being formed by a waveguide with a so-called microstrip structure.
- 30 7. Antenna according to Claim 6, characterised in that the

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1 resonating/radiating conductor (3), the so-called patch, is
formed by a conductor plate of quadrilateral, preferably
rectangular, shape which coincides with the middle zone of
an earth conductor plate (4), a so-called earth plane, from
5 which it is separated by a layer of dielectric material (2),
preferably by a plate of solid dielectric material.

8. Antenna according to Claim 7, characterised in that the
point (P) for detecting and supplying the modulating
signals, during reception and transmission, coincides with
10 the middle point of one of the lateral edges (103) of the
resonating/radiating conductor (3).

9. Antenna according to Claims 7 or 8, characterised in
that the insertion point (I) of the detector/mixer diode (6)
is provided so as to coincide with the median axis (M)
15 parallel to the side (103) of the resonating/radiating
conductor (3) on which the detection and supply point (9) is
provided, and at a predetermined distance (D) from one of
the sides (203) of the resonating/radiating conductor
transverse relative to the said median axis (M), which
20 distance is determined experimentally and/or theoretically
so as to ensure optimum impedance matching of the
resonating/radiating conductor (3) at the insertion point
(I) with the impedance of the detector/mixer diode (6) at
the carrier wave frequency.

25 10. Antenna according to Claim 9, characterised in that the
distance (D) of the insertion point (I) on the median axis
(M), from the side of the resonating/radiating conductor (3)
is determined by the relation with the input impedance Z_{in}
of the resonating/radiating conductor (3) at the insertion
30 point (I) at the said carrier wave frequency w_{10} , defined by



1 the following equation:

$$Z_{in} = Z_{in}(L, W, D, h, K_o, Z_o, \epsilon_r, Q_T, w_{10})$$

where:

5 L, W: dimensions of the sides (103, 203) of the resonating/radiating conductor (3)

D : distance of the insertion point (I) from the side (203) of the resonating/radiating conductor (3) transverse relative to the median axis (M)

h : thickness of the dielectric element (2)

10 K_o : $2\pi/\lambda_o$ with λ_o : wavelength in air

Z_o : characteristic impedance of vacuum

ϵ_r : dielectric constant

Q_T : merit factor of the antenna (calculable)

w_{10} : resonant frequency,

15 while the input impedance Z_{in} corresponds to an empirical or experimental value aimed at optimising the impedance matching between detector/mixer diode (6) and resonating/radiating conductor (3), during reception and transmission/reflection, in particular of the order of
20 magnitude of or even identical to the impedance of the detector/mixer diode (6).

11. Antenna according to one or more of Claims 7 to 10, characterised in that the detector/mixer diode (6) is connected to the radiating antenna structure (1), on the
25 side where the earth conductor plate (4) is located, an extension (7) being provided on the said side for connecting the resonating/radiating conductor (3) to the detector/mixer diode (6) which coincides with the zone of the insertion point (I) and is insulated electrically from the earth
30 conductor plate (4), while the said connection extension (7)





- 1 is connected electrically to the opposite resonating/radiating conductor (3) by means of a tubular conducting bush (8) coaxial with the insertion point (I) and passing through from one side to the other of the dielectric plate (2).
- 5 12. Antenna according to one or more of the preceding claims, characterised in that, in the case of polarised carrier waves, the detector/mixer diode (6) is oriented, with the axis (C) connecting the two pins (106), in a predetermined manner with respect to the sides of the
- 10 resonating/radiating conductor (3) and, in particular, in the case of plane polarised waves, the said axis (C) is oriented parallel to the side (203) of the resonating/radiating conductor (3) which is transverse relative to the median axis (M) coinciding with the
- 15 insertion point (I), the said side (203) being oriented at angle of 90° with respect to the plane of polarisation of the electric field of the carrier wave.
13. Antenna according to one or more of the preceding claims, characterised in that the detector/mixer diode (6)
- 20 constitutes a demodulator preferably of amplitude-modulated carrier waves received and a frequency modulator of the carrier waves transmitted/reflected, preferably a mixer of the carrier wave transmitted/reflected with a frequency-modulated medium frequency signal.
- 25 14. Antenna according to one or more of the preceding claims, characterised in that in the range of microwaves, in particular of the order of magnitude of 1A to 20 GHz, preferably 5 to 10 GHz, the distance (D) of the insertion point (I) is determined in correspondance with a matched
- 30 input impedance Z_{in} of the resonating/radiating conductor



1 (3) at the insertion point (I) from 10 to 100 ohms, in particular from 40 to 50 ohms.

15. Antenna according to Claim 14, characterised in that, for a carrier wave at 5.76 GHz, the dimensions of the 5 resonating/radiating conductor (3) are of the order of ten millimetres or so for the sides (203) oriented transversely relative to the median axis (M) and for the sides (103) parallel to the said median axis (M), whereas the distance (D) of the insertion point (I) from one of the said 10 transverse sides is of the order of a few millimetres.



ABSTRACT

1

Antenna for transceiver devices or the like

In an antenna for transceiver devices or the like, in
5 order to eliminate the presence of separate modulators and
demodulators and the associated circuits, according to the
invention a detector/mixer diode (6) is associated with the
radiating antenna structure (1), so as to form a single
device which is alternately able to receive a modulated
10 carrier wave and demodulate from the said wave the
modulation signals received as well as modulate, with local
modulation signals, a carrier wave, reflecting it for
example back to the emitting source. The modulation signals
received and the local modulation signals transmitted are
15 respectively detected and supplied to the radiating
structure (1) at a point (P) of the said structure, where
the electric field of the carrier wave is equal to zero. The
point of insertion (I) of the detector/mixer diode (6) in
the radiating structure (1) is determined so as to obtain
20 optimum matching between the impedance of the radiating
structure (1) at the insertion point (I) and of the
detector/mixer diode (6), during reception and transmission.



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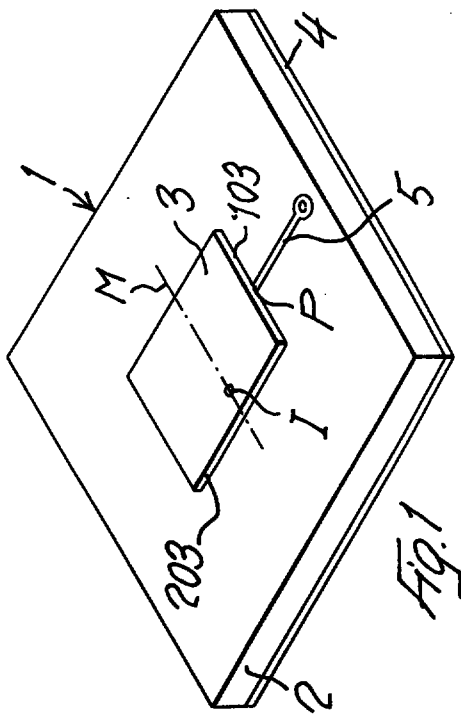


Fig. 1

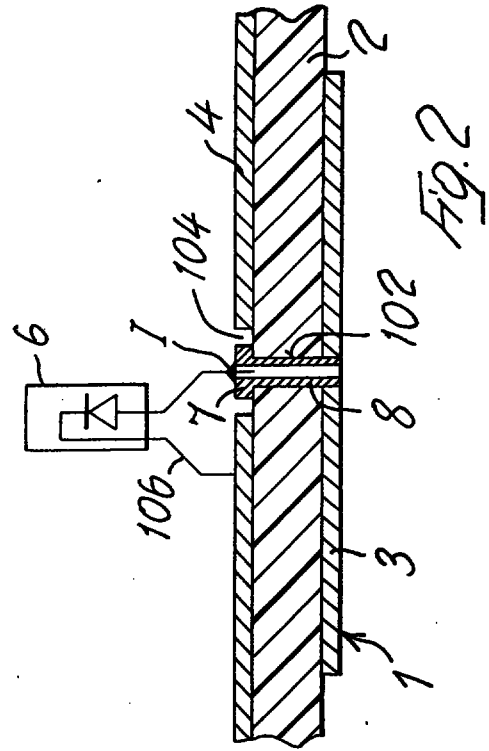


Fig. 2

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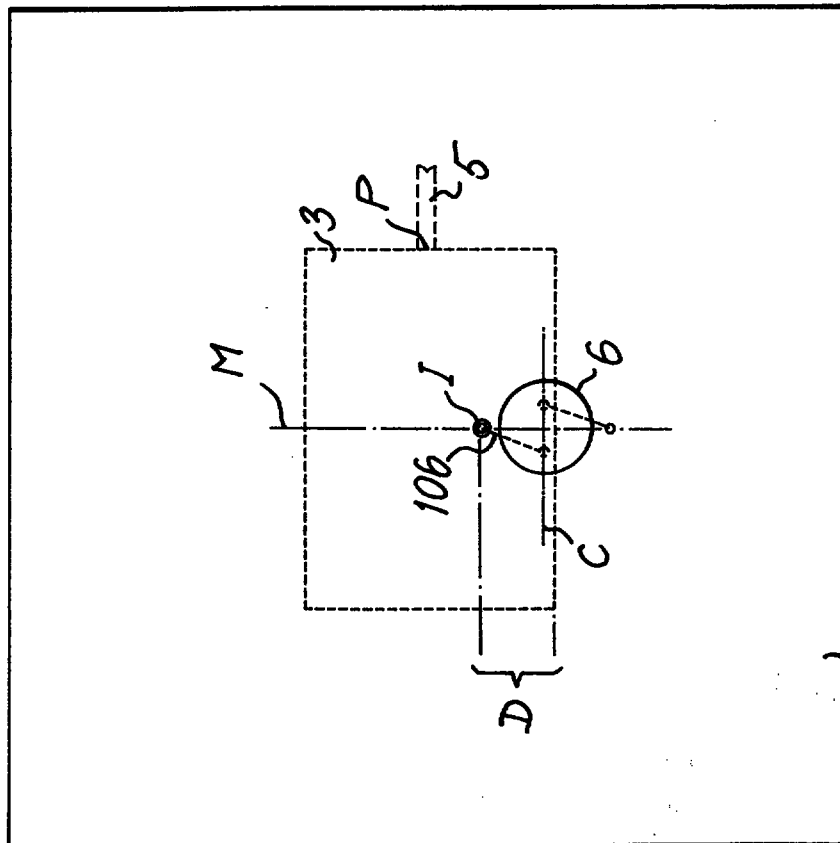


Fig. 3

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ABSTRACT

Antenna for transceiver devices or the like

In an antenna for transceiver devices or the like, in
5 order to eliminate the presence of separate modulators and
demodulators and the associated circuits, according to the
invention a detector/mixer diode (6) is associated with the
radiating antenna structure (1), so as to form a single
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10 carrier wave and demodulate from the said wave the
modulation signals received as well as modulate, with local
modulation signals, a carrier wave, reflecting it for
example back to the emitting source. The modulation signals
received and the local modulation signals transmitted are
15 respectively detected and supplied to the radiating
structure (1) at a point (P) of the said structure, where
the electric field of the carrier wave is equal to zero. The
point of insertion (I) of the detector/mixer diode (6) in
the radiating structure (1) is determined so as to obtain
20 optimum matching between the impedance of the radiating
structure (1) at the insertion point (I) and of the
detector/mixer diode (6), during reception and transmission.

Figure 1

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ANTENNA FOR TRANSCEIVER DEVICES OR THE LIKE

The invention relates to an antenna for transceiver devices or the like, having a radiating structure which is provided in combination with a single detector/mixer diode; - the radiating structure being formed by a waveguide with a so-called microstrip structure having a resonating/radiating conductor formed by a conductor plate of quadrilateral, preferably rectangular, shape which coincides with the middle zone of an earth conductor plate, a so-called earth plane, from which it is separated by a layer of dielectric material, preferably by a plate of solid dielectric material;

- the detector/mixer diode connecting said resonating/radiating conductor with the earth conductor;
- the resonating/radiating conductor being connected at a predetermined point to an input/output conductor for the received signals and the transmitted signals.

Document GB-A-2223130 (see Fig. 3) discloses an antenna of the above mentioned kind, being formed by a patch antenna connected to a local oscillator. The patch and the earth plate of the antenna are connected together by a mixer diode. The point of connection of the mixer diode to the patch is located off-centre of a patch diagonal, in one corner. The radiative signals received by the antenna and the local oscillator signals fed to it excite resonances with non zero amplitudes at the mixer connection point. The radiative and the local oscillator signals are therefore combined on the antenna patch for subsequent mixing. The mixer diode develops intermediate frequency signals which are extracted from the antenna patch through a coaxial lead having an internal conductor and an outer shield. The internal conductor is bonded to the centre of the antenna patch, while the shield is connected to the earth plane of the antenna. The

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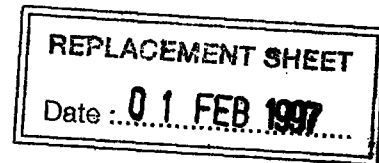
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intermediate frequency signal must then be further processed for extracting the information signals carried by the received waves.

Document EP-A-0 412 884 related to a system for data transmission between an active central station and at least one passive local station. The passive local station are able to receive and demodulate a modulated carrier wave transmitted from the central station and to locally modulate and to reflect back an unmodulated carrier wave transmitted to it by the central station using the same antenna for alternatively transmitting and receiving. Also this antenna shows a microstrip radiating structure. For extracting the received information signals and charging the information signals to be transmitted the antenna must be provided in combination with modulators and demodulators units.

Document DE-A-40 17 625 discloses a microwave transponder having an antenna which is formed by two microstrip-conductors being complanar and longitudinally aligned and which are spaced apart one of the other with their facing ends. This two facing ends of the two conductors are connected together by a diode. By commuting the diode in an on and off state of conduction the antenna radiating structure is alternatively able to getting in resonance or not with the carrier wave. This allows to perform modulation and demodulation of the carrier wave without providing modulation or demodulation units. In order to adjust and dimensionate the antenna in the way as to obtain maximum efficiency, the microstrip-conductors' length, their distance and the position of the diode can be suitably adjusted.

In the transceiver devices, extraction, from the modulated carrier wave received, of the modulation signals containing logic information, and superimposition, on the carrier wave transmitted, of the logic information contained in local



modulation signals are generally performed by means of demodulators and modulators. Modulators and demodulators are also used in so-called "transponders", i.e. receiving/reflecting devices which, instead of generating their own transmission carrier wave, use for transmission the carrier wave, preferably unmodulated, which they receive from a remote transmitting station and which is modulated by them and then reflected back. These devices possess the advantage that they do not require local oscillators and the corresponding power circuits for generation of the carrier wave. On account of their small dimensions, they are used extensively in telecommunications and in control and remote identification systems where they are combined with local control devices or with the identification units. The frequency ranges used may be of any kind and in particular are within the microwave range. Owing to the growing automation and robotisation of industrial processes and plants of all kinds, there is a tendency towards increasingly widespread use of such systems. This has given rise to the need to improve the transceiver/reflecting devices and reduce their costs and dimensions as far as possible, with the development of special technologies in the microwave range.

The object of the invention, therefore, is to provide an antenna for transceiver devices or the like, in particular for receiving/reflecting devices, which results in a simple, inexpensive and extremely compact design of such devices, all of which without adversely affecting, but on the contrary actually improving their operation and performance.

The invention achieves the above objects with an antenna for transceiver devices or the like, as claimed in Claim 1.

The antenna is able to receive a carrier wave, preferably unmodulated, and modulate the said wave with local modulation

signals, reflecting it back.

Demodulation of the signals received and modulation with the local transmission signals is therefore performed without having to use separate demodulators and modulators, together with the corresponding filters, local oscillators and the usual circuitry associated with them. In addition to the reduction in the number of components and the extremely simple design, a considerable reduction in the dimensions is also achieved. The point chosen for detection and supplying of the modulation signals received and transmitted ensures that the carrier is confined entirely in the resonating/radiating conductor, and the point of insertion chosen for the detector/mixer diode on the resonating/radiating conductor forms the optimum connection between diode and conductor. This results in optimisation of both the level of the demodulated signals received and the efficiency of reflection of the locally modulated carrier.

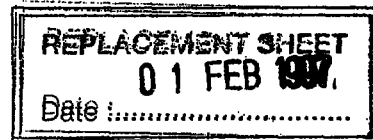
The invention also relates to other features which further improve the abovementioned antenna and which are described in the subclaims.

The characteristic details of the invention and the advantages resulting therefrom will emerge more clearly from the description of a preferred embodiment, illustrated by way of a non-limiting example in the accompanying drawings, in which:

Figure 1 shows a perspective view of the side of the antenna constructed in microstrip technology, where the so-called patch is located;

Figure 2 shows a cross-section through the antenna of Figure 1 in the area of the detector/mixer diode and along the line II-II of Figure 3.

Figure 3 shows a plan view of the side of the antenna



according to the preceding figures, where the so-called reference earth plane is located.

In the example shown in the Figures, the antenna according to the invention is constructed in so-called microstrip technology, already used for the construction of waveguides for propagating signals in the microwave briefly "antenna" below, consists of two conductors separated by a solid dielectric element. The said structure comprises a rectangular plate 2 of dielectric material, on each face of which a thin conducting plate 3, 4 is fixed. One of the two conducting plates 4, called an "earth plane", covers the entire surface of the dielectric plate 2. The other conducting plate 3, the so-called "patch", is arranged in the centre of the opposite face of the dielectric plate 2 and has a rectangular shape with dimensions significantly smaller than those of the earth plane 4. The so-called patch 3 forms the resonating/radiating conductor, while the earth plane 4 performs the function of an artificial earth. From a supply and detection point of one of its shortest sides 103, there extends an input/output conductor 5 to which the remainder of the circuit of a transceiver device (not shown), for example a transponder, is connected.

A diode 6 connects the patch 3 to the earth plane 4. The point of connection of the diode 6 to the patch 3, the so-called insertion point I, coincides with the median axis M parallel to the shortest side 103 of the patch 3, while it is arranged at a given distance D from one of the longitudinal sides 203 of the patch 3 perpendicular to the said median axis M. The diode 6 is arranged in the direction of conduction from the patch 3 to the earth plane 4 (Figure 2) and is fixed to the antenna 1 on the side where the earth plane 4 is located. In particular (Figure 2), in the region of the insertion point I, the earth plane 4 has a through-aperture 104, inside which an extension 7 of the patch

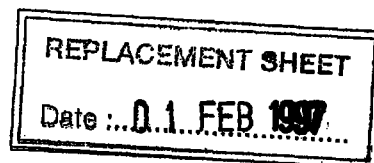
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3 forming a connection to the detector/mixer diode 6 is accommodated so as to be electrically insulated from the earth plane 4 itself. The connection extension 7, on the side where the earth plane 4 is located, is connected electrically to the patch 3 by means of a tubular conducting bush 8 which passes from one side to the other of the dielectric plate 2 through a hole 102 coinciding with the insertion point I itself.

The insertion point I of the detector/mixer diode 6 is determined so as to obtain the optimum impedance matching of the antenna 1 with the detector/mixer diode 6. Determination of the insertion point I is not easy, since the detector/mixer diode 6 acts alternately as a loading device for the antenna 1 and generator, during reception and transmission. Matching of the impedance of the antenna 1 at the insertion point I with the impedance of the detector/mixer diode 6 must be performed taking this into account, in order to optimise simultaneously the efficiency during reception and that during transmission/reflection.

For this purpose, the insertion point I may be determined experimentally or theoretically. In the latter case, the insertion point I is calculated to a good and adequate degree of approximation, as is the point of the patch 3, the input impedance of which assumes a predetermined value matching the impedance of the detector/mixer diode 6, in particular for example of the order of magnitude of the impedance of the detector/mixer diode 6 or approximately identical to the impedance of the same at the resonant frequency w_{10} of the radiating antenna structure (1). Obviously the radiating structure (1) is constructed such that the resonant frequency w_{10} coincides substantially with the frequency of the carrier wave.

With reference to the present example in which the insertion



point I is arranged on the median axis M of the patch 3 parallel to the side 103 on which the detection and supply point P is provided, the distance D of the insertion point I from one of the sides 203 of the patch 3 transverse relative to the said median axis M is defined by the relation with the input impedance Z_{in} of the radiating structure 1 at the insertion point I at the resonant frequency w_{10} :

$$Z_{in} = Z_{in}(L, W, D, h, K_0, Z_0, \epsilon\tau, Q_T, W_{10})$$

where:

- L: length of the side 203 of the patch 3
- W: length of the side 103 of the patch 3
- D: distance of the insertion point I from the side 203 of the patch 3
- h: distance of the patch 3 from the earth plane 4
- K_0 : $2\pi/\lambda_0$ with λ_0 : wavelength in air
- Z_0 : characteristic impedance of vacuum
- $\epsilon\tau$: dielectric constant
- Q_T : merit factor of the antenna (calculable)
- W_{10} : resonant frequency

The point P for detecting and supplying the demodulated signals received and the local modulation signals is determined so as to coincide with the point of the patch 3-where the electric field generated by the carrier wave is equal to zero.

During reception of a modulated carrier wave, the diode 6 acts as detector, extracting from the modulated carrier the modulation signals and hence the information transmitted therein. Owing to the particular arrangement of the insertion point I, the level of the demodulated signals is optimised. As a result of the positioning of the detection and supply point P, automatic filtering of all the components of the carrier wave confined in the patch 3 can be achieved. Only the baseband signals relating to the information transmitted are output from the patch 3, thus

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avoiding the need for both a conventional envelope demodulator and the filters associated therewith.

During reflection, the diode 6 acts as a modulator of the carrier wave which during this phase is transmitted preferably unmodulated and which is confined in the patch 3. The local modulation signals are sent to the antenna 1 at the detection and supply point P. Modulation can be performed without the use of local oscillators and the usual additional circuits associated therewith. The arrangement of the point P for detecting and supplying the modulated signals received and transmitted, and of the insertion point I of the diode 6 prevent diffusion of the carrier wave beyond the detection and supply point P towards the internal circuits and thus result in optimum efficiency of reflection of the carrier wave itself, modulated with the local modulation signals.

The efficiency of the antenna according to the invention both during reception and transmission/reflection is also influenced by additional parameters which depend in each case on the operating conditions, such as type of modulation, structure of the analog or digital signals, wavelength of the carrier and frequency of the modulation signals, and type of polarisation. All of this influences the dimensions of the antenna, the choice of diode, the polarisation current of the diode, where present, and the orientation of the antenna and/or the diode itself.

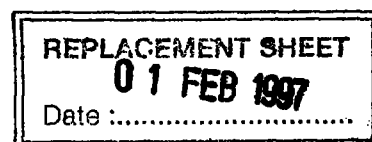
In the case, for example, of a system with at least one transmitting/receiving station and a transponder, in which a carrier wave of between 5.72 and 5.8 GHz is used to send information to the transponder, it is appropriate to modulate the amplitude of the carrier, whereas, in order to send data from the transponder to the station, the carrier is frequency-modulated. When the data received and transmitted are of the digital type

it is preferable to use ASK amplitude modulation during reception and frequency modulation of the carrier during transmission/reflection, as in the case where the carrier is mixed with a medium frequency signal obtained from frequency modulation, for example FEK modulation.

By varying the polarisation current of the detector/mixer diode 6, it is possible to modify and correct the waveform and the amplitude of the modulating signals, in particular during reception.

In this case, the dimensions of the antenna, in particular the patch 3, are extremely small, namely of the order of ten millimetres or so for the side 103 and 203, while the distance D of the insertion point from the side 203 of the patch 3 is a few millimetres. Further-more, in view of the extremely small dimensions of the patch 3, the tolerances for determining the insertion point I are relatively large, the extension of the pins 106 of the detector/mixer diode 6 not being insignificant compared to the surface area of the patch 3. In this case, for most of the commercially available diodes 6 with characteristics suitable for the purpose, it has been shown that the impedance matching between radiating antenna structure 1 and diode 6 is almost always ensured, within the context of the operational requirements of the antenna, when the impedance of the radiating structure 1, or the patch 3, at the insertion point is between 10 and 100 ohms, in particular from 40 to 50 ohms.

With special plane polarisation of the carrier wave, the efficiency of the antenna both during reception and reflection is optimum when, as shown in Figure 3, the diode 6 is oriented with the axis C which joins the two pins 106, parallel to the side 203 of the patch 3, the said side 203 of the patch 3 and the said axis C being oriented at an angle of 90° with respect to the

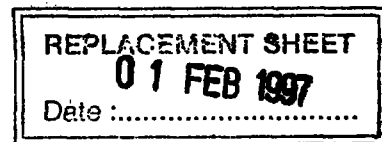


plane containing the electric field of the carrier wave.

Obviously, the invention is not limited to the embodiments described and illustrated herein, but may also be substantially varied and modified, in particular from a constructional point of view. The antenna/diode structure of the present invention may be used with any type of radiating antenna structure for any type of use, all of which without departing from the underlying principle described above and claimed below.

Claims

1. Antenna for transceivers devices or the like, having a radiating structure (1) which is provided in combination with a single detector/mixer diode (6).
 - the radiating structure (1) being formed by a waveguide with a so-called microstrip structure (1) having a resonating/radiating conductor (3) formed by a conductor plate of quadrilateral, preferably rectangular, shape which coincides with the middle zone of an earth conductor plate (4), a so-called earth plane, from which it is separated by a layer of dielectric material (2), preferably by a plate of solid dielectric material;
the detector/mixer diode (6) connecting said resonating/radiating conductor (3) with the earth conductor (4);
 - the resonating/radiating conductor (3) being connected at a predetermined point (P) to an input/output conductor (5) for the received signals and the transmitted signals, characterized in that
 - the detector/mixer diode (6) is connected to the resonating/radiating conductor (3) and to the earth



plane containing the electric field of the carrier wave.

Obviously, the invention is not limited to the embodiments described and illustrated herein, but may also be substantially varied and modified, in particular from a constructional point of view. The antenna/diode structure of the present invention may be used with any type of radiating antenna structure for any type of use, all of which without departing from the underlying principle described above and claimed below.

Claims

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the detector/mixer diode (6) connecting said resonating/radiating conductor (3) with the earth conductor (4);
 - the resonating/radiating conductor (3) being connected at a predetermined point (P) to an input/output conductor (5) for the received signals and the transmitted signals, characterized in that
 - the detector/mixer diode (6) is connected to the resonating/radiating conductor (3) and to the earth

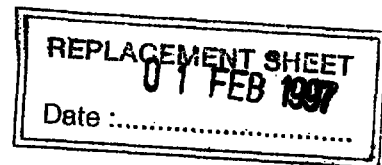


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conductor (4), being oriented in the direction of conduction from the resonating/radiating conductor (3) to the earth conductor (4);

- the detector/mixer diode (6) being connected to the resonating/radiating conductor (3) at such a point (I) of the said conductor (3) (insertion point) as to obtain optimum impedance matching between the characteristic impedance of the radiating structure (1), or of the resonating/radiating conductor (3), with reference to the said insertion point (I), and the impedance of the detector/mixer diode (6);
- the detector/mixer diode (6) being arranged on one side of the antenna structure (1) outside said structure (1) and having a predetermined orientation with respect to the antenna structure, depending on the fact whether the carrier wave is polarised and on the predetermined direction of polarisation of the carrier wave;
- the conductor (5) for detecting and supplying respectively the received signals and the transmitted signals being connected at a point (P) of the resonating/radiating conductor (3) at which the electric field of the carrier wave is equal to zero;
- so as to form an integrated device for receiving modulated carrier waves and demodulating at the same time from said modulated carrier wave the modulation signals received and for modulating with locally generated modulation signals a locally generated carrier wave and transmitting said modulated carrier wave or modulate with said locally generated modulation signals an unmodulated carrier wave received and reflecting it back, the demodulated modulation signals received and the modulation signals transmitted being respectively directly detected at



- and directly supplied to the point (P) of the resonating/radiating conductor (3) without processing the signals in further modulation or demodulation units.
2. Antenna according to Claim 1, characterized in that the resonating/radiating conductor (3) has a resonant frequency corresponding to the frequency of the carrier wave used, the insertion point (I) of the detector mixer diode (6) on the said resonating/radiating conductor (3) coinciding with the point of the resonating/radiating conductor (3) where the characteristic impedance is of the order of magnitude of or substantially identical to the impedance of the detector/mixer diode (6) at the resonant frequency w_{10} corresponding to the frequency of the carrier wave.
 3. Antenna according to one or more of the preceding claims, characterised in that the detector/mixer diode (6) may have applied to it a polarisation current which constitutes a parameter for adjusting and correcting the waveform and amplitude, in particular of the modulation signals received.
 4. Antenna according to one or more of the preceding claims, characterised in that the point (P) for detecting and supplying the modulating signals, during reception and transmission, coincides with the middle point of one of the lateral edges (103) of the resonating/radiating conductor (3).
 5. Antenna according to Claim 4, characterised in that the insertion point (I) of the detector/mixer diode (6) is provided so as to coincide with the median axis (M) parallel to the side (103) of the resonating/radiating conductor (3) on which the detection and supply point (9)



is provided, and at a predetermined distance (D) from one of the sides (203) of the resonating/radiating conductor transverse relative to the said median axis (M), which distance is determined experimentally and/or theoretically so as to ensure optimum impedance matching of the resonating/radiating conductor (3) at the insertion point (I) with the impedance of the detector/mixer diode (6) at the carrier wave frequency.

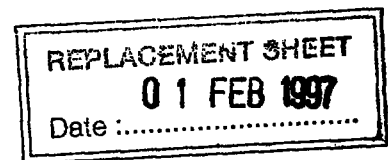
6. Antenna according to Claim 5, characterised in that the distance (D) of the insertion point (I) on the median axis (M), from the side of the resonating/radiating conductor (3) is determined by the relation with the input impedance Z_{in} of the resonating/radiating conductor (3) at the insertion point (I) at the said carrier wave frequency w_{10} , defined by the following equation:

$$Z_{in} = Z_{in} (L, W, D, h, K_o, Z_o, \epsilon T, Q_T, W_{10})$$

where:

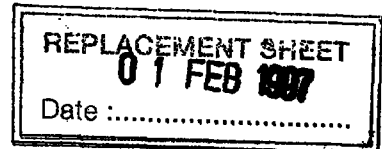
- L, W: dimensions of the sides (103, 203) of the resonating/radiating conductor (3)
D: distance of the insertion point (I) from the side (203) of the resonating/radiating conductor (3) transverse relative to the median axis (M)
h: thickness of the dielectric element (2)
 K_o : $2\pi/\lambda_o$ with λ_o : wavelength in air
 Z_o : characteristic impedance of vacuum
 ϵT : dielectric constant
 Q_T : merit factor of the antenna (calculable)
 W_{10} : resonant frequency,

while the input impedance Z_{in} corresponds to an empirical or experimental value aimed at optimising the impedance matching between detector/mixer diode (6) and resonating/radiating conductor (3), during reception and transmission/reflection, in particular of the order of



magnitude of or even identical to the impedance of the detector/mixer diode (6).

7. Antenna according to one or more of Claims 4 to 6, characterised in that the detector/mixer diode (6) is connected to the radiating antenna structure (1), on the side where the earth conductor plate (4) is located, an extension (7) being provided on the said side for connecting the resonating/radiating conductor (3) to the detector/mixer diode (6) which coincides with the zone of the insertion point (I) and is insulated electrically from the earth conductor plate (4), while the said connection extension (7) is connected electrically to the opposite resonating/radiating conductor (3) by means of a tubular conducting bush (8) coaxial with the insertion point (I) and passing through from one side to the other of the dielectric plate (2).
8. Antenna according to one or more of the preceding claims, characterised in that, in the case of polarised carrier waves, the detector/mixer diode (6) is oriented, with the axis (C) connecting the two pins (106), in a predetermined manner with respect to the sides of the resonating/radiating conductor (3) and, in particular, in the case of plane polarised waves, the said axis (C) is oriented parallel to the side (203) of the resonating/radiating conductor (3) which is transverse relative to the median axis (M) coinciding with the insertion point (I), the said side (203) being oriented at angle of 90° with respect to the plane of polarisation of the electric field of the carrier wave.
9. Antenna according to one or more of the preceding claims,



characterised in that the detector/mixer diode (6) constitutes a demodulator preferably of amplitude-modulated carrier waves received and a frequency modulator of the carrier waves transmitted/reflected, preferably a mixer of the carrier wave transmitted/reflected with a frequency-modulated medium frequency signal.

10. Antenna according to one or more of the preceding claims, characterised in that the range of microwaves, in particular of the order of magnitude of 1A to 20 GHz, preferably 5 to 10 GHz, the distance (D) of the insertion point (I) is determined in correspondance with a matched input impedance Z_{in} of the resonating/radiating conductor (3) at the insertion point (I) from 10 to 100 ohms, in particular from 40 to 50 ohms.
11. Antenna according to Claim 10, characterised in that, for a carrier wave at 5.76 GHz, the dimensions of the resonating/radiating conductor (3) are of the order of ten millimetres or so for the sides (203) oriented transversely relative to the median axis (M) and for the sides (103) parallel to the said median axis (M), whereas the distance (D) of the insertion point (I) from one of the said transverse sides is of the order of a few millimetres.

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